PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2004-214796
(43)Date of publication of application : 29.07.2004

(51)Int.Cl. H04R 17/00
H01L 41/083
H01L 41/09

(21)Application number : 2002-379742
(22)Date of filing : 27.12.2002

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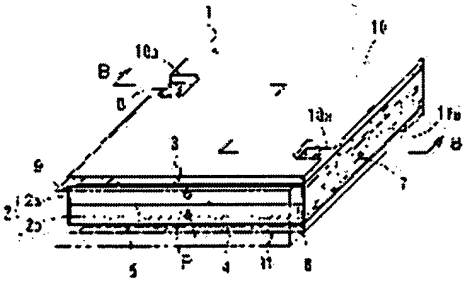
(54) PIEZOELECTRIC DIAPHRAGM AND PIEZOELECTRIC ELECTROACOUSTIC TRANSDUCER USING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a piezoelectric diaphragm which more improves the shock resistance while ensuring an electric conduction reliability of main electrodes on the front and back surfaces to the side electrodes.

SOLUTION: Main surface electrodes 3, 4 formed on the front and back surfaces of a rectangular laminate 2 of a plurality of piezoelectric ceramic layers are made conductive through a side electrode 7, inner electrodes 5 each formed between the ceramic layers are made conductive to a side electrode 9 and the electrode 9 is made conductive to a leading electrode 8. Resin layers 10, 11 approximately entirely cover the front and back main surfaces of the laminate 2 and have notches 10a, 11a respectively cut into one-side peripheral parts along the side electrode 7 to expose the leading electrode 8. The resin layer 10 on the front surface has a notch 10b cut into the other-side peripheral part along the side electrode 9 to expose the leading electrode 8. The notches 10a, 11a of the front and back resin layers 10, 11 locate at not opposed positions.



LEGAL STATUS

[Date of request for examination]	18.05.2004
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

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[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

* NOTICES *

CLAIMS

[Claim(s)]

[Claim 1]

It is the piezo-electric diaphragm which carries out a crookedness oscillation by forming a principal plane electrode in the front flesh-side principal plane of the layered product of the square which carried out the laminating of two or more electrostrictive ceramics layers, forming an internal electrode between each ceramic layer, and impressing an AC signal between the principal plane electrode of a front flesh side, and an internal electrode,

The principal plane electrode of a front flesh side flowed mutually through the 1st side-face electrode formed in one side face of a layered product, and the internal electrode flowed with the 2nd side-face electrode formed in a different side face from the 1st side-face electrode, and the 2nd side-face electrode has flowed with the drawer electrode of a layered product formed in the table principal plane at least,

In the one side section of the resin layer of the front flesh side of the front flesh-side principal plane of the above-mentioned layered product which the whole surface is mostly covered in the resin layer, and met the side-face electrode of the above 1st In the piezo-electric diaphragm with which the 1st and 2nd notch which some principal plane electrodes of a front flesh side expose was formed, respectively, and the 3rd notch which a drawer electrode exposes to other one side section of the resin layer on a side front which met the 2nd side-face

electrode was formed The 1st and 2nd notch of the resin layer of the above-mentioned table flesh side is a piezo-electric diaphragm characterized by being formed in the location which does not counter mutually.

[Claim 2]

The 1st notch of the above is prepared near the end section of the side section of the resin layer on a side front which met the 1st side-face electrode,

The 2nd notch of the above is prepared near the other end of the side section of the resin layer on a background which met the 1st side-face electrode,

The 3rd notch of the above is a piezo-electric diaphragm according to claim 1 characterized by being prepared near one edge of the side sections of the resin layer on a side front which met the 2nd side-face electrode.

[Claim 3]

A piezo-electric diaphragm according to claim 1 or 2 and the above-mentioned piezo-electric diaphragm are contained. The case which has the supporter which supports the perimeter or the corner section of two sides in which the 1st side-face electrode of a piezo-electric diaphragm and the 2nd side-face electrode were formed, and which counter, or a piezo-electric diaphragm, It is the piezo-electric mold electroacoustic transducer equipped with the terminal of the couple fixed to the case so that the end section might be exposed to the medial surface of the case near [above-mentioned] the supporter and the other end might be exposed to the outside surface of a case. The piezo-electric mold electroacoustic transducer characterized by for some principal plane electrodes on a side front exposed from the 1st notch of the above and the end section of one terminal being connected by electroconductive glue, and the drawer electrode exposed from the 3rd notch of the above and an other-end child's end section being connected by electroconductive glue.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention relates to the piezo-electric diaphragm used for a piezo-electric receiver, a piezo-electric sounder, etc., and the piezo-electric mold electroacoustic transducer using this piezo-electric diaphragm.

[0002]

[Description of the Prior Art]

[Patent reference 1] JP,2001-95094,A

[Patent reference 2] JP,2002-10393,A

Conventionally, in electronic equipment, home electronics, a portable telephone, etc., the piezo-electric mold electroacoustic transducer is widely used as a piezo-electric sounder or a piezo-electric receiver. In this kind of piezo-electric mold electroacoustic transducer, what used the bimorph mold piezo-electricity diaphragm which consists of electrostrictive ceramics of a laminated structure is proposed by the patent reference 1.

[0003]

This piezo-electric diaphragm forms a principal plane electrode in the front flesh-side principal plane of this layered product, forms an internal electrode between each ceramic layer, and polarizes all ceramic layers in the same direction in the thickness direction while it carries out the laminating of two-layer or the three-

layer electrostrictive ceramics layer and forms a layered product. And the crookedness oscillation of the layered product is carried out by impressing an AC signal between the principal plane electrode of a front flesh side, and an internal electrode. Thus, a piezo-electric diaphragm consists of the laminating structure of the ceramics, and since two oscillating fields (ceramic layer) arranged in order in the thickness direction vibrate to hard flow mutually, compared with a uni-morph mold piezo-electricity diaphragm, the big amount of displacement, i.e., big sound pressure, can be obtained.

[0004]

However, since this piezo-electric diaphragm consists of only electrostrictive ceramics layers, it has the fault of being weak, to impulse force, such as a drop impact. then -- the patent reference 2 -- the table rear face of a layered product -- almost -- the whole surface -- thin -- the piezo-electric diaphragm of the structure covered in the **** resin layer is proposed. Thus, since a resin layer does not check the crookedness oscillation of a layered product while a layered product can be reinforced and shatter strength improves substantially by [of the front flesh-side principal plane of a layered product] covering the whole surface in a resin layer mostly, sound pressure is hardly spoiled and it has the description that resonance frequency does not rise greatly. Moreover, it becomes possible to be able to carry out the lamination of the ceramic layer which constitutes a layered product further, and to raise a sound pressure property further by reinforcing a layered product, by the resin layer.

[0005]

Drawing 8 - drawing 10 show an example of such a piezo-electric diaphragm. The piezo-electric diaphragm 40 is equipped with the layered product 41 which carried out the laminating of the two-layer electrostrictive ceramics layers 41a and 41b which consist of PZT etc., the principal plane electrodes 42 and 43 are formed in the front flesh-side principal plane of a layered product 41, and the internal electrode 44 is formed among the ceramic layers 41a and 41b. As an arrow head P shows, in the thickness direction, polarization of the two ceramic

layers 41a and 41b is carried out in the same direction. The principal plane electrode 42 on a side front and the principal plane electrode 43 on a background are prolonged from one side of a layered product 41 to just before the side of another side, and the internal electrode 44 is symmetrically prolonged from the side of another side to just before one side with the principal plane electrodes 42 and 43. The table rear face of a layered product 41 is covered with the resin layers 45 and 46.

[0006]

The principal plane electrodes 42 and 43 and the flowing side-face electrode 47 are formed in one side face of a layered product 41, and the internal electrode 44 and the flowing side-face electrode 48 are formed in the side face in which a layered product 41 counters. The vertical section of the side-face electrode 48 has flowed with the drawer electrode 49 formed along the edge on the rear face of a table of a layered product 41. The notches 45a and 46a which some principal plane electrodes 42 and 43 of a front flesh side expose, and the notches 45b and 46b which some drawer electrodes 49 expose are formed in the resin layers 45 and 46. The piezo-electric diaphragm 40 can be contained in a case with a terminal, and the piezo-electric diaphragm 40 and a terminal can be electrically connected by connecting the electrode exposed to the terminal exposed in the case from the notches 45a and 45b of the resin layer 45 on a side front with electroconductive glue.

[0007]

[Problem(s) to be Solved by the Invention]

In the piezo-electric diaphragm 40 of the above-mentioned configuration, it is the center section of the side where the notches 45a and 46a of the resin layers 45 and 46, and 45b and 46b counter, and is prepared in the location which carries out front flesh-side opposite. Among these, the reason for forming the notches 45a and 46a to which some principal plane electrodes 42 and 43 of a front flesh side are exposed in the resin layers 45 and 46 of a front flesh side is as follows. Namely, although the side-face electrodes 47 and 48 are formed after they form

the resin layers 45 and 46 in the front flesh side of a layered product 41 Since the principal plane electrodes 42 and 43 consist of a thin film electrode, the exposure area of the principal plane electrodes 42 and 43 exposed from between the resin layers 45 and 46 and the ceramic layers 41a and 41b is dramatically small. Flow dependability with the principal plane electrodes 42 and 43 is not securable only by forming the side-face electrode 47 in the side face of the piezo-electric diaphragm 40. Then, Notches 45a and 46a are formed in the side section of the resin layers 45 and 46 of the front flesh side which met the side-face electrode 47, and the flow dependability is secured by rotating some side-face electrodes 47 on the front face of the principal plane electrodes 42 and 43. In addition, although what is necessary is to prepare only in the resin layer 45 on a side front about the notches 45b and 46b to which the drawer electrode 49 is exposed, in order to abolish directivity, it has prepared also in the resin layer 46 on a background.

[0008]

Since Notches 45a, 46a, 45b, and 46b were formed in the front flesh-side opposite location of the resin layers 45 and 46 as mentioned above, when a drop impact was added, the problem of being easy to generate a crack was in the part of the layered product 41 exposed from the notch. When lamination of the layered product 41 is carried out especially, the occurrence frequency of a crack becomes high. In drawing 10 , a broken line CR shows the generating part of a crack. The cause of a crack can consider that the impulse force concentrates on the electrode section exposed from the notch of the resin layers 45 and 46 through electroconductive glue from a case, that the reinforcement of the part of the layered product 41 in which Notches 45a, 46a, 45b, and 46b were formed is insufficient, etc., when acting on the electrode which the hardening contraction stress by electroconductive glue exposed from the notch of the resin layers 45 and 46, and a drop impact are added.

[0009]

Then, the object of this invention is to offer the piezo-electric diaphragm which can raise shock resistance further, and the piezo-electric mold electroacoustic

transducer using this piezo-electric diaphragm, securing the flow dependability of the principal plane electrode of a front flesh side, and a side-face electrode.

[0010]

[Means for Solving the Problem]

In order to attain the above-mentioned object, invention concerning claim 1 A principal plane electrode is formed in the front flesh-side principal plane of the layered product of the square which carried out the laminating of two or more electrostrictive ceramics layers. It is the piezo-electric diaphragm which carries out a crookedness oscillation by forming an internal electrode between each ceramic layer, and impressing an AC signal between the principal plane electrode of a front flesh side, and an internal electrode. The principal plane electrode of a front flesh side flows mutually through the 1st side-face electrode formed in one side face of a layered product. An internal electrode flows with the 2nd side-face electrode formed in a different side face from the 1st side-face electrode. And the 2nd side-face electrode has flowed with the drawer electrode of a layered product formed in the table principal plane at least. In the one side section of the resin layer of the front flesh side of the front flesh-side principal plane of the above-mentioned layered product which the whole surface is mostly covered in the resin layer, and met the side-face electrode of the above 1st In the piezo-electric diaphragm with which the 1st and 2nd notch which some principal plane electrodes of a front flesh side expose was formed, respectively, and the 3rd notch which a drawer electrode exposes to other one side section of the resin layer on a side front which met the 2nd side-face electrode was formed The piezo-electric diaphragm characterized by forming the 1st and 2nd notch of the resin layer of the above-mentioned table flesh side in the location which does not counter mutually is offered.

[0011]

It is because the notch is carrying out front flesh-side opposite of the main cause which a crack generates into the part of the layered product exposed from the notch when a drop impact is added, so the reinforcement of the outcrop of a

layered product runs short. So, by this invention, a resin layer surely exists in the reverse side of a layered product in which the notch was prepared, and the lack of on the strength of a layered product is compensated with forming the notch of the resin layer of a front flesh side in the location which does not counter mutually. Thus, when the notch was prepared in the location which does not carry out front flesh-side opposite, shock resistance improved by leaps and bounds.

Even in this case, since the notch is prepared for the both sides of the resin layer of a front flesh side, when a side-face electrode is formed, it can turn to the side front of the principal plane electrode of a front flesh side, and the flow dependability of the principal plane electrode of a front flesh side and a side-face electrode can be secured.

[0012]

It is good to prepare the 1st notch like claim 2 near the end section of the side section of the resin layer on a side front which met the 1st side-face electrode, to prepare the 2nd notch near the other end of the side section of the resin layer on a background which met the 1st side-face electrode, and to prepare the 3rd notch near one edge of the side sections of the resin layer on a side front which met the 2nd side-face electrode.

In case a piezo-electric diaphragm is contained in a case etc. and the electrode of a diaphragm is connected with a terminal etc., it is necessary to devise so that a diaphragm may not be restrained as much as possible. Then, it becomes possible to connect with the exterior in the location in which the 1st - the 3rd notch are prepared near the edge of the side section of the resin layer of the front flesh side which met the side-face electrode and which does not check an oscillation of a diaphragm as much as possible by preparing near the corner section if it puts in another way. Since the 1st notch and the 2nd notch are especially left and prepared in the both ends of the same side, the stress of one notch does not influence the notch of another side, but can prevent generating of a crack effectively.

[0013]
A piezo-electric diaphragm according to claim 1 or 2 and a piezo-electric diaphragm are contained like claim 3. The case which has the supporter which supports the perimeter or the corner section of two sides in which the 1st side-face electrode of a piezo-electric diaphragm and the 2nd side-face electrode were formed, and which counter, or a piezo-electric diaphragm, It is the piezo-electric mold electroacoustic transducer equipped with the terminal of the couple fixed to the case so that the end section might be exposed to the medial surface of the case near [above-mentioned] the supporter and the other end might be exposed to the outside surface of a case. It is good to consider as the structure where some principal plane electrodes on a side front exposed from the 1st notch and the end section of one terminal are connected by electroconductive glue, and the drawer electrode exposed from the 3rd notch and an other-end child's end section are connected by electroconductive glue.
In case the electrode of a piezo-electric diaphragm and the terminal of a case are connected, it is desirable to use electroconductive glue in respect of workability, flow dependability, and a miniaturization. Since the principal plane electrode and the drawer electrode are exposed from the 1st and 3rd notch of the resin layer on a side front in the case of a piezo-electric diaphragm according to claim 1 or 2, if electroconductive glue is applied by a dispenser etc. from on the after containing a piezo-electric diaphragm in a case, the electrical installation of a terminal and a piezo-electric diaphragm can be attained easily.
[0014]
[Embodiment of the Invention]
Drawing 1 - drawing 3 show the piezo-electric mold electroacoustic transducer of the surface mount mold which is the 1st operation gestalt of this invention.
The electroacoustic transducer of this operation gestalt fitted the application corresponding to the frequency of a large range like a piezo-electric receiver, and is equipped with the piezo-electric diaphragm 1, the case 20, and the cover plate 30. Here, a case consists of a case 20 and a cover plate 30.

[0015]

It has the layered product 2 of the square with which the piezo-electric diaphragm 1 carried out the laminating of two-layer electrostrictive ceramics layer 2a and the 2b as shown in drawing 4 - drawing 6 , the principal plane electrodes 3 and 4 are formed in the front flesh-side principal plane of a layered product 2, and the internal electrode 5 and the dummy electrode 6 are formed between ceramic layer 2a and 2b. As an arrow head P shows, in the thickness direction, polarization of two ceramic layer 2a and 2bs is carried out in the same direction. As shown in drawing 6 , the lack sections 3a and 4a of width of face d were formed in one side of the principal plane electrode 3 on a side front, and the principal plane electrode 4 on a background, and the three remaining sides are prolonged to the side face of a layered product 2. One side of the principal plane electrodes 3 and 4 prolonged to the side face of a layered product 2 is mutually connected by the side-face electrode 7 formed in one side face of a layered product 2. The principal plane electrode 3 and a gap are separated in the front face of a layered product 2 in which lack section 3a of the principal plane electrode 3 on a side front was formed, and the drawer electrode 8 is formed in it. An internal electrode 5 is formed in a rectangle so that it may expose only to the side face of a layered product 2 in which the lack sections 3a and 4a of the principal plane electrodes 3 and 4 were formed, and the dummy electrode 6 is formed in the KO typeface so that a gap may be carried out in between and three sides of an internal electrode 5 may be surrounded. The dummy electrode 6 is exposed to four side faces including the side face of the layered product 2 which the internal electrode 5 exposed. The internal electrode 5 is connected with the drawer electrode 8 by the above-mentioned side-face electrode 7 and the side-face electrode 9 formed in the side face which counters. The side-face electrode 9 is formed shorter than die length of one side of a layered product 2 so that it may not flow with the dummy electrode 6.

Each above-mentioned electrodes 3, 4, 5, 6, 7, 8, and 9 are all thin film electrodes.

In addition, the cross section cut from the edge a little in the location of central approach is expressed to the near side of drawing 4 .

[0016]

When an internal electrode 5 is extended to four side faces of a layered product 2, in the side face of a layered product 2, an internal electrode 5 and the principal plane electrodes 3 and 4 approach in the thickness direction, and since the reason for having formed the dummy electrode 6 as mentioned above has a possibility that the short circuit by migration may occur, it is forming the dummy electrode 6 which separates a gap and encloses an internal electrode 5, and prevents the short circuit by the migration of an internal electrode 5 and the principal plane electrodes 3 and 4.

In addition, it connects also with the dummy electrode 6 at the same time the side-face electrode 7 connects the principal plane electrode 3 and four comrades, but since the dummy electrode 6 is electrically insulated with the internal electrode 5, it is satisfactory to electrical characteristics.

[0017]

In order to prevent the crack of the layered product 2 by the drop impact, the wrap resin layers 10 and 11 are formed in the table rear face of a layered product 2 in the principal plane electrodes 3 and 4. 1st notch 10a which some principal plane electrodes 3 expose, and 3rd notch 10b which the drawer electrode 8 exposes are formed in the resin layer 10 on a side front near the diagonal corner section, and it is formed in the resin layer 11 on a background near [where 2nd notch 11a which some principal plane electrodes 4 expose differs] the corner section. Therefore, 1st notch 10a of the side front resin layer 10 and 2nd notch 11a of the background resin layer 11 which are prepared in the side in which the side-face electrode 7 of a layered product 2 was formed are prepared in the location which does not carry out front flesh-side opposite.

[0018]

here -- as ceramic layer 2a and 2b -- each 10 -- the mmx10mmx15micrometer (the total thickness of 30 micrometers) PZT system ceramics was used.

Moreover, thickness used the polyamidoimide system resin which is 3-10 micrometers as resin layers 10 and 11.

In addition, in order to abolish the directivity of a front flesh side, a drawer electrode and the notch of the resin layer 11 may be prepared also in the rear face of a layered product 2. The drawer electrode and notch in this case are good to prepare near the corner section of notch 11a and a vertical angle.

Moreover, although the drawer electrode 7 was used as the island-like electrode corresponding to notch 10b in the above-mentioned example, it is good also as a band electrode of shortest breadth.

The configuration of Notches 10a, 10b, and 11a is not limited to an example, either.

[0019]

The above-mentioned piezo-electric diaphragm 1 is manufactured as follows, for example.

The ceramic layer of two sheets of a set substrate condition is prepared, and after carrying out an internal electrode 5 and the dummy electrode 6 in between, carrying out the laminating of both the ceramic layer and calcinating, the layered product of a set substrate condition is obtained by forming the principal plane electrodes 3 and 4 and the drawer electrode 8, and the becoming electrode in the table rear face by sputtering etc. The resin layers 10 and 11 which have a predetermined window hole used as a notch are formed in the table rear face of this layered product with screen printing etc. Next, the layered product of a set substrate condition is cut with a predetermined dimension in all directions, and the layered product (with a resin layer) of the piece condition of an individual is obtained. The piezo-electric diaphragm 1 shown in drawing 4 is obtained by forming the side-face electrodes 7 and 9 in two side faces in which the layered product of the piece condition of an individual counters, by sputtering etc. after an appropriate time.

[0020]

The case 20 is formed in the core box of the square which has bottom wall

section 20a and the four side-attachment-wall sections 20b-20e with a resin ingredient. As a resin ingredient, heat-resistant resin, such as LCP (liquid crystal polymer), SPS (syndiotactic polystyrene), PPS (polyphenylene sulfide), and epoxy, is desirable. 20f (level difference section) of annular supporters was formed in the inner circumference of the four side-attachment-wall sections 20b-20e, and the internal connection sections 21a and 22a of the terminals 21 and 22 of a couple are exposed on 20f of supporters of the inside which are the two side-attachment-wall sections 20b and 20d which counter. the internal connection sections 21a and 22a of terminals 21 and 22 -- respectively -- two forks -- it is formed in a ** and located near the corner section of the piezo-electric diaphragm 1. It is fixed to a case 20 by insert molding etc., and terminals 21 and 22 are bent to the base side of a case 20 along the outside surface whose external connections 21b and 22b which exposed to the exterior of a case 20 are the side-attachment-wall sections 20b and 20d.

[0021]

Inside the four side-attachment-wall sections 20b-20e, as shown in drawing 1 and drawing 2 , 20g of guide walls for carrying out location regulation of the four sides which the piezo-electric diaphragm 1 counters protrudes. Therefore, if the piezo-electric diaphragm 1 is contained in a case 20, four sides of the piezo-electric diaphragm 1 will be guided with 20g of guide walls, and will be laid in the predetermined location on 20f of supporters by accuracy. At this time, the top panel of the piezo-electric diaphragm 1 and the top face of the internal connection sections 21a and 22a of terminals 21 and 22 become the same height mostly.

In addition, 20h of 1st sound emission hole is formed in bottom wall section 20a.

[0022]

Connection immobilization of the piezo-electric diaphragm 1 contained by the case 20 is carried out by the elastic support agent 23 and electroconductive glue 24 by four places at the internal connection sections 21a and 22a of terminals 21 and 22. That is, the elastic support agent 23 is applied between the principal

plane electrode 3 exposed to 1st notch 10a in a diagonal location, and one internal connection section 21a of a terminal 21, and between the drawer electrode 8 exposed to 3rd notch 10b, and one internal connection section 22a of a terminal 22. Although the elastic support agent 23 is applied about two in the remaining diagonal location in this example, this elastic support agent 23 is omissible. Although the elastic support agent 23 was applied a line or in the shape of an ellipse along the side side of the piezo-electric diaphragm 1 here, a spreading configuration is not restricted to this. As an elastic support agent 23, soft elastic adhesives [like the urethane system adhesives of 3.7x106 Pa] whose Young's modulus after hardening is are used, for example. Moreover, the viscosity in the condition of this elastic support agent 23 of not hardening is high, and since it has the property which cannot permeate easily, when the elastic support agent 23 is applied, there is no possibility that the elastic support agent 23 may flow and fall to 20f of supporters through the clearance between the piezo-electric diaphragm 1 and a case 20. Heat hardening is carried out after applying the elastic support agent 23.

In addition, as the fixed approach of the piezo-electric diaphragm 1, after containing the piezo-electric diaphragm 1 in a case 20, the elastic support agent 23 may be applied by a dispenser etc., but where the elastic support agent 23 is beforehand applied to the piezo-electric diaphragm 1, the piezo-electric diaphragm 1 may be held in a case 20.

[0023]

After stiffening the elastic support agent 23, electroconductive glue 24 is applied a line or in the shape of an ellipse so that the elastic support agent 23 top may be crossed, and the principal plane electrode 3, internal connection section 21a of a terminal 21 and the drawer electrode 8, and internal connection section 22a of a terminal 22 are connected, respectively. As electroconductive glue 24, the urethane system conductive paste of 0.3x109 Pa is used for the Young's modulus after the conductive paste which has elasticity, for example, hardening. After applying electroconductive glue 24, heat hardening of this is carried out.

The spreading configuration of electroconductive glue 24 is not restricted above, and just connects the principal plane electrode 3, internal connection section 21a and the drawer electrode 8, and internal connection section 22a ranging over the elastic support agent 23.

[0024]

After applying and stiffening electroconductive glue 24, the elastic encapsulant 25 is applied to the clearance between the perimeter perimeter of the piezo-electric diaphragm 1, and the inner circumference section of a case 20, and the air leak between the side front of the piezo-electric diaphragm 1 and a background is prevented. Heat hardening is carried out after applying the elastic encapsulant 25 annularly. As elastic encapsulant 25, the silicone system adhesives of 3.0x105 Pa are used for the Young's modulus behind a soft spring material, for example, hardening.

[0025]

After fixing the piezo-electric diaphragm 1 to a case 20 as mentioned above, a cover plate 30 pastes top-face opening of a case 20 with adhesives 31. A cover plate 30 is formed with the same ingredient as a case 20. By pasting up a cover plate 30, sound space is formed between a cover plate 30 and the piezo-electric diaphragm 1. The 2nd sound emission hole 32 is formed in the cover plate 30. The piezo-electric mold electroacoustic transducer of a surface mount mold is completed as mentioned above.

[0026]

At the electroacoustic transducer of this operation gestalt, the crookedness oscillation of the piezo-electric diaphragm 1 can be carried out in area crookedness mode by impressing a predetermined AC signal between a terminal 21 and 22. Since the electrostrictive ceramics layer the direction of polarization and whose direction of electric field are the same directions is shrunken in the direction of a flat surface and the electrostrictive ceramics layer the direction of polarization and whose direction of electric field are hard flow is extended in the direction of a flat surface, it is crooked in the thickness direction as a whole. the

resin layers 10 and 11 which have covered the table rear face of a layered product 2 especially -- thin -- since it is a **** resin layer, the crookedness oscillation of a layered product 2 is not checked, and sound pressure is hardly spoiled, and resonance frequency does not rise greatly

[0027]

A table 1 shows the result of the drop test of an electroacoustic transducer. Conventionally, structure is an electroacoustic transducer using the piezo-electric diaphragm shown in drawing 8 - drawing 10 , and is an electroacoustic transducer using the piezo-electric diaphragm indicated to be this invention structure to drawing 4 - drawing 6 .

When 6th page drop was made into 1 cycle and it fell up to 5 cycle, it judged whether the crack and the crack occurred in the part in which the notch of a piezo-electric diaphragm was prepared. Conditions other than the location of a notch presupposed that it is the same. O The generating nothing of a crack and x show those with generating.

Conventionally, when drop height was set to 120cm or more, to the crack having occurred, even if drop height was set to 180cm, a crack did not occur, but the effectiveness which was excellent in this invention structure was confirmed by this invention structure with structure, so that clearly from a table 1.

[0028]

[A table 1]

落下高さ	従来構造	本発明構造
１００ｃｍ	○	○
１２０ｃｍ	×	○
１５０ｃｍ	×	○
１８０ｃｍ	×	○

[0029]
Drawing 7 shows other examples of the piezo-electric diaphragm concerning this invention.
This piezo-electric diaphragm pastes up the piezo-electric diaphragm 1 shown in drawing 4 - drawing 6 on the resin film 15 more large-sized than this. As a resin film 15, by about 5-10 micrometers in thickness, the ingredient of 500MPa-15000MPa has good Young's modulus, and resin films, such as an epoxy system, acrylic, a polyimide system, and a polyamidoimide system, are specifically used. If the piezo-electric diaphragm 1 is stuck on the center section of such a large-sized resin film 15 and the periphery section of the resin film 15 is fixed to the supporter of a case, it can support without restraining the piezo-electric diaphragm 1 strongly, and the piezo-electric diaphragm 1 will much more become easy to vibrate. Therefore, while being able to enlarge the amount of displacement of the piezo-electric diaphragm 1 and being able to obtain high sound pressure, even if it makes the dimension of the piezo-electric diaphragm 1 small, equivalent resonance frequency can be obtained. Moreover, the sound pressure which does not have depression from basic resonance to the 3rd resonance is obtained, and it can respond to playback of wideband voice.
[0030]
This invention is not limited to the above-mentioned operation gestalt, and can be changed in the range which does not deviate from the meaning of this invention. Although the piezo-electric diaphragm of the above-mentioned operation gestalt carries out the laminating of the two-layer electrostrictive ceramics layer, what carried out the laminating of the three or more-layer electrostrictive ceramics layer may be used.
Moreover, although 20f of annular supporters which support four sides of the piezo-electric diaphragm 1 was formed in the inner circumference of a case 20, the supporter which supports two sides or the four corner sections of the piezo-electric diaphragm 1 may be formed.

The case of this invention contains a piezo-electric diaphragm, and does not restrict it to what consisted of a case of a concave cross-section configuration like an operation gestalt, and a cover plate adhered to the top face that what is necessary is just to prepare an external terminal or an electrode.

[0031]

[Effect of the Invention]

Since the 1st and 2nd notch of the resin layer formed in the table rear face of a piezo-electric diaphragm was formed in the location which does not counter mutually by the above explanation according to invention according to claim 1 so that clearly It could prevent that a crack occurred into the part of the layered product which exposed this piezo-electric diaphragm from the notch when a drop impact joined a case, where receipt immobilization is carried out, and the shock resistance to a drop impact was able to be raised substantially. Moreover, since the notch is prepared in the resin layer of a front flesh side, respectively, a side-face electrode can be rotated on the side front of a principal plane electrode, and the flow dependability of the principal plane electrode of a front flesh side and a side-face electrode can be secured.

[Brief Description of the Drawings]

[Drawing 1] It is the decomposition perspective view of the 1st operation gestalt of the piezo-electric mold electroacoustic transducer concerning this invention.

[Drawing 2] It is a top view in the condition of having excepted the cover plate and elastic encapsulant of a piezo-electric mold electroacoustic transducer which are shown in drawing 1 .

[Drawing 3] It is the A-A line stairway sectional view of drawing 2 .

[Drawing 4] It is the perspective view of the piezo-electric diaphragm used for the piezo-electric mold electroacoustic transducer of drawing 1 .

[Drawing 5] It is a stairway sectional view by the B-B line of drawing 4 .

[Drawing 6] It is the decomposition perspective view of the piezo-electric diaphragm of drawing 4 .

[Drawing 7] It is the perspective view of other examples of the piezo-electric

diaphragm concerning this invention.

[Drawing 8] It is the perspective view of an example of the conventional piezo-electric diaphragm.

[Drawing 9] It is the C-C line sectional view of drawing 8 .

[Drawing 10] It is the top view of the piezo-electric diaphragm of drawing 8 .

[Description of Notations]

1 Piezo-electric Diaphragm

2 Layered Product

3 Four Principal plane electrode

5 Internal Electrode

7 1st Side-Face Electrode

8 Drawer Electrode

9 2nd Side-Face Electrode

10 11 Resin layer

10a The 1st notch

10b The 3rd notch

11a The 2nd notch

20 Case

21 22 Terminal

24 Electroconductive Glue

25 Elastic Encapsulant

30 Cover Plate

[Translation done.]

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the decomposition perspective view of the 1st operation gestalt of the piezo-electric mold electroacoustic transducer concerning this invention.

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[Drawing 8] It is the perspective view of an example of the conventional piezo-electric diaphragm.

[Drawing 9] It is the C-C line sectional view of drawing 8 .

[Drawing 10] It is the top view of the piezo-electric diaphragm of drawing 8 .

[Description of Notations]

1 Piezo-electric Diaphragm

2 Layered Product

3 Four Principal plane electrode

5 Internal Electrode

7 1st Side-Face Electrode

8 Drawer Electrode

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10 11 Resin layer

10a The 1st notch

10b The 3rd notch

11a The 2nd notch

20 Case

21 22 Terminal

24 Electroconductive Glue

25 Elastic Encapsulant

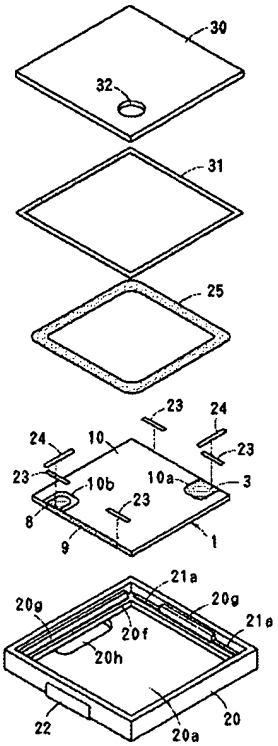
30 Cover Plate

[Translation done.]

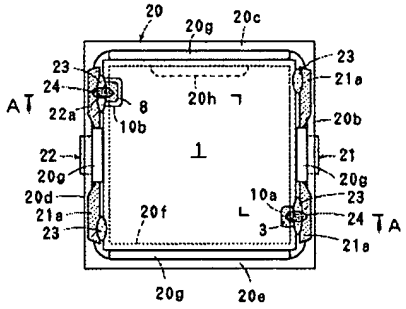
* NOTICES *

DRAWINGS

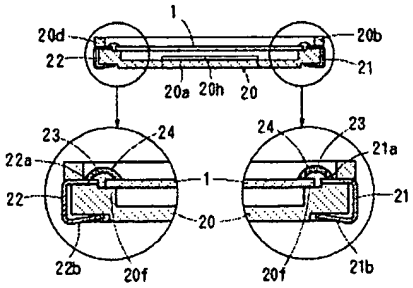
[Drawing 1]



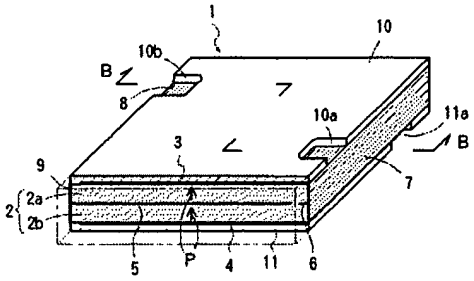
[Drawing 2]



[Drawing 3]



[Drawing 4]



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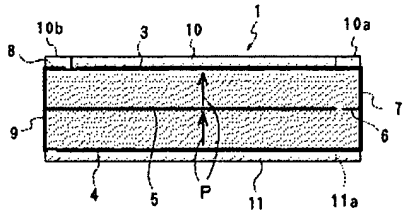

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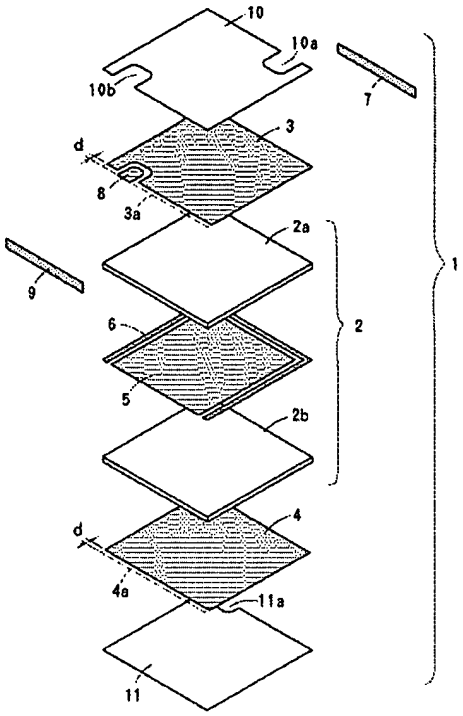
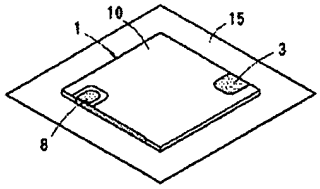
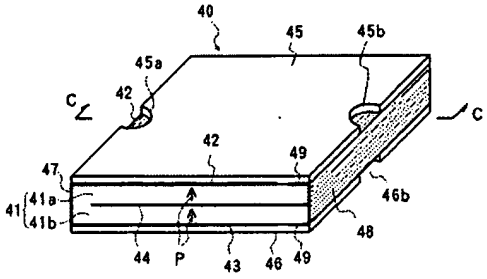


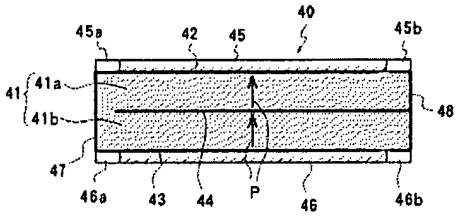
[Drawing 7]



[Drawing 8]



[Drawing 9]



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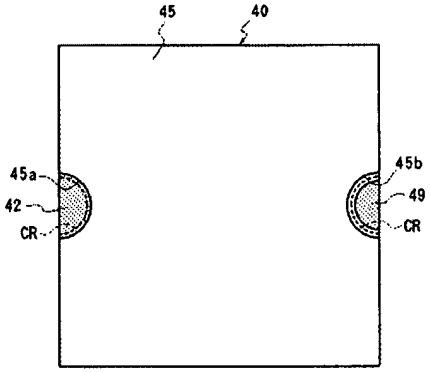

[Translation done.]

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2004-214796
(P2004-214796A)
(43)公開日　平成16年7月29日(2004.7.29)

(51)Int.Cl.[7]	F I		テーマコード（参考）
H04R 17/00	H04R 17/00		5D004
H01L 41/083	H01L 41/08	S	
H01L 41/09	H01L 41/08	U	

審査請求 未請求　請求項の数 3　OL　（全 10 頁）

(21)出願番号　特願2002-379742(P2002-379742)
(22)出願日　平成14年12月27日(2002.12.27)

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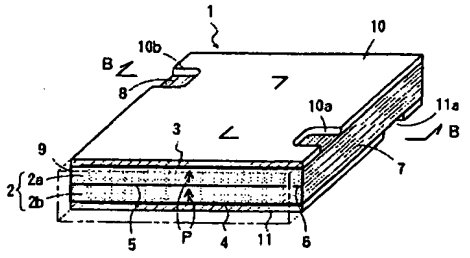
Fターム(参考)　5D004 AA07　BB01　CC01　FF09

(54)【発明の名称】圧電振動板およびこの圧電振動板を用いた圧電型電気音響変換器

(57)【要約】
【課題】表裏の主面電極と側面電極との導通信頼性を確保しながら、耐衝撃性をさらに高めることができる圧電振動板を提供する。
【解決手段】複数の圧電セラミックス層を積層した四角形の積層体２の表裏主面に主面電極３，４を形成し、各セラミックス層の間に内部電極５を形成し、主面電極３，４を側面電極７を介して導通させ、内部電極５を側面電極９と導通させ、かつ側面電極９を引出電極８と導通させる。積層体２の表裏主面のほぼ全面を樹脂層１０，１１で覆い、側面電極７に沿った表裏の樹脂層の１つの辺部に主面電極３，４の一部が露出する切欠部１０ａ，１１ａをそれぞれ形成し、側面電極９に沿った表側の樹脂層１０の他の１つの辺部に引出電極８が露出する切欠部１０ｂを形成する。表裏の樹脂層１０，１１の切欠部１０ａ，１１ａを互いに対向しない位置に形成する。
【選択図】図４



【特許請求の範囲】
【請求項１】
複数の圧電セラミックス層を積層した四角形の積層体の表裏主面に主面電極が形成され、各セラミックス層の間に内部電極が形成され、表裏の主面電極と内部電極との間に交流信号を印加することにより屈曲振動する圧電振動板であって、
表裏の主面電極は積層体の１つの側面に形成された第１の側面電極を介して互いに導通し、内部電極は第１の側面電極と異なる側面に形成された第２の側面電極と導通し、かつ第２の側面電極は積層体の少なくとも表主面に形成された引出電極と導通しており、
上記積層体の表裏主面のほぼ全面が樹脂層で覆われており、上記第１の側面電極に沿った表裏の樹脂層の１つの辺部に、表裏の主面電極の一部が露出する第１，第２切欠部がそれぞれ形成され、第２の側面電極に沿った表側の樹脂層の他の１つの辺部に、引出電極が露出する第３切欠部が形成された圧電振動板において、上記表裏の樹脂層の第１，第２切欠部は、互いに対向しない位置に形成されていることを特徴とする圧電振動板。
【請求項２】
上記第１切欠部は、第１の側面電極に沿った表側の樹脂層の辺部の一端部近傍に設けられ、
上記第２切欠部は、第１の側面電極に沿った裏側の樹脂層の辺部の他端部近傍に設けられ、
上記第３切欠部は、第２の側面電極に沿った表側の樹脂層の辺部のいずれかの端部近傍に設けられていることを特徴とする請求項１に記載の圧電振動板。
【請求項３】
請求項１または２に記載の圧電振動板と、上記圧電振動板を収納し、圧電振動板の第１の側面電極および第２の側面電極が形成された対向する２辺、あるいは圧電振動板の全周またはコーナ部を支持する支持部を有する筐体と、上記支持部近傍の筐体の内側面に一端部が露出し、他端部が筐体の外面に露出するよう筐体に固定された一対の端子とを備えた圧電型電気音響変換器であって、上記第１切欠部から露出する表側の主面電極の一部と一方の端子の一端部とが導電性接着剤により接続され、上記第３切欠部から露出する引出電極と他方の端子の一端部とが導電性接着剤により接続されていることを特徴とする圧電型電気音響変換器。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】
本発明は圧電レシーバや圧電サウンダなどに用いられる圧電振動板およびこの圧電振動板を用いた圧電型電気音響変換器に関するものである。
【０００２】
【従来の技術】
【特許文献１】特開２００１－９５０９４号公報
【特許文献２】特開２００２－１０３９３号公報
従来、電子機器、家電製品、携帯電話機などにおいて、圧電サウンダや圧電レシーバとして圧電型電気音響変換器が広く用いられている。この種の圧電型電気音響変換器において、積層構造の圧電セラミックスよりなるバイモルフ型圧電振動板を使用したものが、特許文献１で提案されている。
【０００３】
この圧電振動板は、２層または３層の圧電セラミックス層を積層して積層体を形成するとともに、この積層体の表裏主面に主面電極を形成し、各セラミックス層の間に内部電極を形成し、すべてのセラミックス層を厚み方向に同一方向に分極したものである。そして、表裏の主面電極と内部電極との間に交流信号を印加することで、積層体を屈曲振動させる。このように、圧電振動板がセラミックスの積層構造体よりなり、厚み方向に順に配置された２つの振動領域（セラミックス層）が相互に逆方向に振動するので、ユニモルフ型圧電振動板に比べて大きな変位量、つまり大きな音圧を得ることができる。

【０００４】
ところが、この圧電振動板は圧電セラミックス層だけで構成されているため、落下衝撃などの衝撃力に対して弱いという欠点がある。そこで、特許文献２では、積層体の表裏面のほぼ全面を薄肉な樹脂層で覆った構造の圧電振動板が提案されている。このように積層体の表裏主面のほぼ全面を樹脂層で覆うことにより、積層体を補強でき、落下強度が大幅に向上するとともに、樹脂層は積層体の屈曲振動を阻害するものではないので、音圧を殆ど損なわず、また共振周波数が大きく上昇することがないという特徴を有する。また、樹脂層によって積層体を補強することで、積層体を構成するセラミックス層をさらに薄層化でき、音圧特性を一層向上させることが可能になる。
【０００５】
図８～図１０はこのような圧電振動板の一例を示す。
圧電振動板４０は、ＰＺＴなどからなる２層の圧電セラミックス層４１ａ，４１ｂを積層した積層体４１を備えており、積層体４１の表裏主面には主面電極４２，４３が形成され、セラミックス層４１ａ，４１ｂの間には内部電極４４が形成されている。２つのセラミックス層４１ａ，４１ｂは、矢印Ｐで示すように厚み方向において同一方向に分極されている。表側の主面電極４２と裏側の主面電極４３は、積層体４１の一方の辺から他方の辺の直前まで延びており、内部電極４４は主面電極４２，４３と対称的に他方の辺から一方の辺の直前まで延びている。積層体４１の表裏面は樹脂層４５，４６によって覆われている。
【０００６】
積層体４１の一方の側面には、主面電極４２，４３と導通する側面電極４７が形成され、積層体４１の対向する側面には、内部電極４４と導通する側面電極４８が形成されている。側面電極４８の上下部は積層体４１の表裏面の縁部に沿って形成された引出電極４９と導通している。樹脂層４５，４６には、表裏の主面電極４２，４３の一部が露出する切欠部４５ａ，４６ａと、引出電極４９の一部が露出する切欠部４５ｂ，４６ｂとが形成されている。圧電振動板４０を端子付きのケースに収納し、ケース内に露出した端子に対して表側の樹脂層４５の切欠部４５ａ，４５ｂから露出した電極を導電性接着剤により接続することで、圧電振動板４０と端子とを電気的に接続することができる。
【０００７】
【発明が解決しようとする課題】
上記構成の圧電振動板４０では、樹脂層４５，４６の切欠部４５ａ，４６ａおよび４５ｂ，４６ｂが対向する辺の中央部であって、表裏対向する位置に設けられている。このうち、表裏の主面電極４２，４３の一部を露出させる切欠部４５ａ，４６ａを表裏の樹脂層４５，４６に設ける理由は、次の通りである。すなわち、側面電極４７，４８は積層体４１の表裏に樹脂層４５，４６を形成した後で形成されるが、主面電極４２，４３が薄膜電極よりなるので、樹脂層４５，４６とセラミックス層４１ａ，４１ｂとの間から露出している主面電極４２，４３の露出面積が非常に小さく、側面電極４７を圧電振動板４０の側面に形成しただけでは主面電極４２，４３との導通信頼性を確保できない。そこで、側面電極４７に沿った表裏の樹脂層４５，４６の辺部に切欠部４５ａ，４６ａを形成し、側面電極４７の一部を主面電極４２，４３の表面に回り込ませることで、その導通信頼性を確保したものである。なお、引出電極４９を露出させる切欠部４５ｂ，４６ｂについては、表側の樹脂層４５にのみ設ければよいが、方向性をなくすため、裏側の樹脂層４６にも設けてある。
【０００８】
上記のように樹脂層４５，４６の表裏対向位置に切欠部４５ａ，４６ａ，４５ｂ，４６ｂが設けられているため、落下衝撃が加わった場合に、切欠部から露出した積層体４１の部分にクラックが発生しやすいという問題があった。特に、積層体４１を薄層化した場合にクラックの発生頻度が高くなる。図１０において、破線ＣＲはクラックの発生箇所を示す。クラックの原因は、導電性接着剤による硬化収縮応力が樹脂層４５，４６の切欠部から露出した電極に作用すること、落下衝撃が加わった時にその衝撃力がケースから導電性接

着剤を介して樹脂層４５，４６の切欠部から露出した電極部分に集中すること、切欠部４５ａ，４６ａ，４５ｂ，４６ｂが設けられた積層体４１の部分の強度が不足していること、などが考えられる。

【０００９】

そこで、本発明の目的は、表裏の主面電極と側面電極との導通信頼性を確保しながら、耐衝撃性をさらに高めることができる圧電振動板およびこの圧電振動板を用いた圧電型電気音響変換器を提供することにある。

【００１０】

【課題を解決するための手段】

上記目的を達成するため、請求項１に係る発明は、複数の圧電セラミックス層を積層した四角形の積層体の表裏主面に主面電極が形成され、各セラミックス層の間に内部電極が形成され、表裏の主面電極と内部電極との間に交流信号を印加することにより屈曲振動する圧電振動板であって、表裏の主面電極は積層体の１つの側面に形成された第１の側面電極を介して互いに導通し、内部電極は第１の側面電極と異なる側面に形成された第２の側面電極と導通し、かつ第２の側面電極は積層体の少なくとも表主面に形成された引出電極と導通しており、上記積層体の表裏主面のほぼ全面が樹脂層で覆われており、上記第１の側面電極に沿った表裏の樹脂層の１つの辺部に、表裏の主面電極の一部が露出する第１，第２切欠部がそれぞれ形成され、第２の側面電極に沿った表側の樹脂層の他の１つの辺部に、引出電極が露出する第３切欠部が形成された圧電振動板において、上記表裏の樹脂層の第１，第２切欠部は、互いに対向しない位置に形成されていることを特徴とする圧電振動板を提供する。

【００１１】

落下衝撃が加わった場合に切欠部から露出した積層体の部分にクラックが発生する主たる原因は、切欠部が表裏対向しているため、積層体の露出部の強度が不足するからである。そこで、本発明では、表裏の樹脂層の切欠部を互いに対向しない位置に形成することで、切欠部が設けられた積層体の反対面には必ず樹脂層が存在し、積層体の強度不足を補うようにしたものである。このように、切欠部を表裏対向しない位置に設けたところ、耐衝撃性が飛躍的に向上した。

この場合でも、表裏の樹脂層の双方に切欠部が設けられているので、側面電極を形成した際に表裏の主面電極の表側へ回り込むことができ、表裏の主面電極と側面電極との導通信頼性を確保することができる。

【００１２】

請求項２のように、第１切欠部を第１の側面電極に沿った表側の樹脂層の辺部の一端部近傍に設け、第２切欠部を第１の側面電極に沿った裏側の樹脂層の辺部の他端部近傍に設け、第３切欠部を第２の側面電極に沿った表側の樹脂層の辺部のいずれかの端部近傍に設けるのがよい。

圧電振動板をケースなどに収納し、振動板の電極を端子などと接続する際、できるだけ振動板を拘束しないように工夫する必要がある。そこで、第１～第３切欠部を側面電極に沿った表裏の樹脂層の辺部の端部近傍に設ける、換言するとコーナ部近傍に設けることで、できるだけ振動板の振動を阻害しない位置で外部と接続することが可能になる。特に、第１切欠部と第２切欠部とが同一辺の両端部に離れて設けられているので、一方の切欠部の応力が他方の切欠部に影響せず、クラックの発生を効果的に防止できる。

【００１３】

請求項３のように、請求項１または２に記載の圧電振動板と、圧電振動板を収納し、圧電振動板の第１の側面電極および第２の側面電極が形成された対向する２辺、あるいは圧電振動板の全周またはコーナ部を支持する支持部を有する筐体と、上記支持部近傍の筐体の内側面に一端部が露出し、他端部が筐体の外面に露出するよう筐体に固定された一対の端子とを備えた圧電型電気音響変換器であって、第１切欠部から露出する表側の主面電極の一部と一方の端子の一端部とが導電性接着剤により接続され、第３切欠部から露出する引出電極と他方の端子の一端部とが導電性接着剤により接続されている構造とするのがよい

。
圧電振動板の電極とケースの端子とを接続する際、導電性接着剤を使用することが、作業性、導通信頼性および小型化の面で望ましい。請求項１または２に記載の圧電振動板の場合、表側の樹脂層の第１，第３切欠部から主面電極および引出電極が露出しているので、圧電振動板をケースに収納した後、その上から導電性接着剤をディスペンサなどによって塗布すれば、端子と圧電振動板との電気的接続を簡単に達成できる。

【００１４】

【発明の実施の形態】

図１～図３は本発明の第１の実施形態である表面実装型の圧電型電気音響変換器を示す。この実施形態の電気音響変換器は、圧電レシーバのように広いレンジの周波数に対応する用途に適したものであり、圧電振動板１とケース２０と蓋板３０とを備えている。ここでは、ケース２０と蓋板３０とで筐体が構成される。

【００１５】

圧電振動板１は、図４～図６に示すように、２層の圧電セラミックス層２ａ，２ｂを積層した四角形の積層体２を備えており、積層体２の表裏主面には主面電極３，４が形成され、セラミックス層２ａ，２ｂの間には内部電極５とダミー電極６とが形成されている。２つのセラミックス層２ａ，２ｂは、矢印Ｐで示すように厚み方向において同一方向に分極されている。表側の主面電極３と裏側の主面電極４の１辺には、図６に示すように幅ｄの欠如部３ａ，４ａが形成され、残りの３辺は積層体２の側面まで延びている。積層体２の側面まで延びた主面電極３，４の１辺が、積層体２の一つの側面に形成された側面電極７によって相互に接続されている。表側の主面電極３の欠如部３ａが形成された積層体２の表面には、主面電極３とギャップを隔てて引出電極８が形成されている。内部電極５は、主面電極３，４の欠如部３ａ，４ａが形成された積層体２の側面にのみ露出するように方形に形成され、ダミー電極６は内部電極５の３辺をギャップを間にして取り囲むようにコ字形に形成されている。ダミー電極６は内部電極５が露出した積層体２の側面を含む４つの側面に露出している。内部電極５は、上記側面電極７と対向する側面に形成された側面電極９によって引出電極８と接続されている。側面電極９は、ダミー電極６と導通しないように、積層体２の一辺の長さより短く形成されている。

上記各電極３，４，５，６，７，８，９は、いずれも薄膜電極である。

なお、図４の手前側には、縁部より若干中央寄りの位置で切断した断面を表してある。

【００１６】

上記のようにダミー電極６を設けた理由は、内部電極５を積層体２の４つの側面まで延ばした場合、積層体２の側面において内部電極５と主面電極３，４とが厚み方向に近接し、マイグレーションによる短絡が発生する恐れがあるため、内部電極５をギャップを隔てて取り囲むダミー電極６を設けることで、内部電極５と主面電極３，４とのマイグレーションによる短絡を防止したものである。

なお、側面電極７は主面電極３，４同士を接続すると同時に、ダミー電極６とも接続されるが、ダミー電極６は内部電極５と電気的に絶縁されているので、電気的特性に問題はない。

【００１７】

積層体２の表裏面には、落下衝撃による積層体２の割れを防止するため、主面電極３，４を覆う樹脂層１０，１１が形成されている。表側の樹脂層１０には、主面電極３の一部が露出する第１切欠部１０ａと、引出電極８が露出する第３切欠部１０ｂとが対角のコーナ部近傍に形成されており、裏側の樹脂層１１には、主面電極４の一部が露出する第２切欠部１１ａが異なるコーナ部近傍に形成されている。そのため、積層体２の側面電極７が形成された辺に設けられる表側樹脂層１０の第１切欠部１０ａと裏側樹脂層１１の第２切欠部１１ａとが表裏対向しない位置に設けられている。

【００１８】

ここでは、セラミックス層２ａ，２ｂとして各１０ｍｍ×１０ｍｍ×１５μｍ（総厚み３０μｍ）のＰＺＴ系セラミックスを使用した。また、樹脂層１０，１１として厚みが３～

１０μｍのポリアミドイミド系樹脂を使用した。
なお、表裏の方向性をなくすため、積層体２の裏面にも、引出電極と樹脂層１１の切欠部とを設けてもよい。この場合の引出電極および切欠部は、切欠部１１ａと対角のコーナ部近傍に設けるのがよい。
また、上記実施例では、引出電極７を切欠部１０ｂに対応した島状電極としたが、短幅の帯状電極としてもよい。
切欠部１０ａ，１０ｂ，１１ａの形状も実施例に限定されない。
【００１９】
上記圧電振動板１は、例えば次のように製造される。
集合基板状態の２枚のセラミックス層を準備し、両セラミックス層を内部電極５およびダミー電極６を間にして積層し、焼成した後、その表裏面に主面電極３，４および引出電極８となる電極をスパッタリングなどによって形成することで、集合基板状態の積層体を得る。この積層体の表裏面に、切欠部となる所定の窓穴を有する樹脂層１０，１１をスクリーン印刷法などによって形成する。次に、集合基板状態の積層体を縦横に所定の寸法でカットし、個片状態の積層体（樹脂層付き）を得る。しかる後、個片状態の積層体の対向する２側面にスパッタリングなどによって側面電極７，９を形成することにより、図４に示す圧電振動板１が得られる。
【００２０】
ケース２０は樹脂材料で底壁部２０ａと４つの側壁部２０ｂ～２０ｅとを持つ四角形の箱型に形成されている。樹脂材料としては、ＬＣＰ（液晶ポリマー），ＳＰＳ（シンジオタクチックポリスチレン），ＰＰＳ（ポリフェニレンサルファイド），エポキシなどの耐熱樹脂が望ましい。４つの側壁部２０ｂ～２０ｅの内周には環状の支持部（段差部）２０ｆが設けられ、対向する２つの側壁部２０ｂ，２０ｄの内側の支持部２０ｆ上に、一対の端子２１，２２の内部接続部２１ａ，２２ａが露出している。端子２１，２２の内部接続部２１ａ，２２ａはそれぞれ二股状に形成され、圧電振動板１のコーナ部近傍に位置している。端子２１，２２はケース２０にインサート成形などによって固定されたものであり、ケース２０の外部に露出した外部接続部２１ｂ，２２ｂが側壁部２０ｂ，２０ｄの外面に沿ってケース２０の底面側へ折り曲げられている。
【００２１】
４つの側壁部２０ｂ～２０ｅの内側には、図１，図２に示すように、圧電振動板１の対向する４辺を位置規制するためのガイド壁２０ｇが突設されている。そのため、ケース２０に圧電振動板１を収納すると、圧電振動板１の４辺がガイド壁２０ｇでガイドされ、支持部２０ｆ上の所定位置に正確に載置される。このとき、圧電振動板１の天面と端子２１，２２の内部接続部２１ａ，２２ａの上面とがほぼ同一高さになる。
なお、底壁部２０ａには第１の放音孔２０ｈが形成されている。
【００２２】
ケース２０に収納された圧電振動板１は、４箇所で弾性支持剤２３および導電性接着剤２４によって端子２１，２２の内部接続部２１ａ，２２ａに接続固定される。すなわち、対角位置にある第１切欠部１０ａに露出する主面電極３と端子２１の一方の内部接続部２１ａとの間、および第３切欠部１０ｂに露出する引出電極８と端子２２の一方の内部接続部２２ａとの間に、弾性支持剤２３が塗布される。この実施例では、残りの対角位置にある２箇所についても弾性支持剤２３が塗布されているが、この弾性支持剤２３は省略できる。ここでは弾性支持剤２３を圧電振動板１の側辺に沿って線状または楕円状に塗布したが、塗布形状はこれに限るものではない。弾性支持剤２３としては、例えば硬化後のヤング率が３．７×10^6 Ｐａのウレタン系接着剤のような柔らかい弾性接着剤が使用される。また、この弾性支持剤２３の未硬化状態での粘性が高く、滲みにくい性質を有するので、弾性支持剤２３を塗布したとき、弾性支持剤２３が圧電振動板１とケース２０との隙間を通って支持部２０ｆまで流れ落ちる恐れがない。弾性支持剤２３を塗布した後、加熱硬化させる。
なお、圧電振動板１の固定方法としては、圧電振動板１をケース２０に収納した後でディ

スペンサなどで弾性支持剤２３を塗布してもよいが、圧電振動板１に予め弾性支持剤２３を塗布した状態で圧電振動板１をケース２０に収容してもよい。

【００２３】

弾性支持剤２３を硬化させた後、導電性接着剤２４を弾性支持剤２３の上を交差するように線状または楕円状に塗布し、主面電極３と端子２１の内部接続部２１ａ、引出電極８と端子２２の内部接続部２２ａとをそれぞれ接続する。導電性接着剤２４としては、弾性を有する導電ペースト、例えば硬化後のヤング率が０．３×１０^{9} Ｐａのウレタン系導電ペーストが使用される。導電性接着剤２４を塗布した後、これを加熱硬化させる。導電性接着剤２４の塗布形状は上記に限るものではなく、弾性支持剤２３を跨いで主面電極３と内部接続部２１ａ、引出電極８と内部接続部２２ａとを接続できればよい。

【００２４】

導電性接着剤２４を塗布，硬化させた後、弾性封止剤２５を圧電振動板１の周囲全周とケース２０の内周部との隙間に塗布し、圧電振動板１の表側と裏側との間の空気漏れを防止する。弾性封止剤２５を環状に塗布した後、加熱硬化させる。弾性封止剤２５としては、柔らかい弾性材料、例えば硬化後のヤング率が３．０×１０^{5} Ｐａのシリコーン系接着剤が使用される。

【００２５】

上記のように圧電振動板１をケース２０に固定した後、ケース２０の上面開口部に蓋板３０が接着剤３１によって接着される。蓋板３０はケース２０と同様な材料で形成される。蓋板３０を接着することで、蓋板３０と圧電振動板１との間に音響空間が形成される。蓋板３０には、第２の放音孔３２が形成されている。

上記のようにして表面実装型の圧電型電気音響変換器が完成する。

【００２６】

この実施形態の電気音響変換器では、端子２１，２２間に所定の交流信号を印加することで、圧電振動板１を面積屈曲モードで屈曲振動させることができる。分極方向と電界方向とが同一方向である圧電セラミックス層は平面方向に縮み、分極方向と電界方向とが逆方向である圧電セラミックス層は平面方向に伸びるので、全体として厚み方向に屈曲する。特に、積層体２の表裏面を覆っている樹脂層１０，１１が薄肉な樹脂層であるから、積層体２の屈曲振動を阻害せず、音圧を殆ど損なわず、また共振周波数が大きく上昇することがない。

【００２７】

表１は電気音響変換器の落下試験の結果を示す。

従来構造とは図８～図１０に示す圧電振動板を用いた電気音響変換器であり、本発明構造とは図４～図６に示す圧電振動板を用いた電気音響変換器である。

６面落下を１サイクルとし、５サイクルまで落下したときに圧電振動板の切欠部を設けた箇所に割れやクラックが発生したかどうかを判断した。切欠部の位置以外の条件は同一とした。○は割れの発生なし、×は発生ありを示す。

表１から明らかなように、従来構造では落下高さが１２０ｃｍ以上になると割れが発生していたのに対し、本発明構造では落下高さが１８０ｃｍになっても割れが発生しておらず、本発明構造の優れた効果が確かめられた。

【００２８】

【表１】

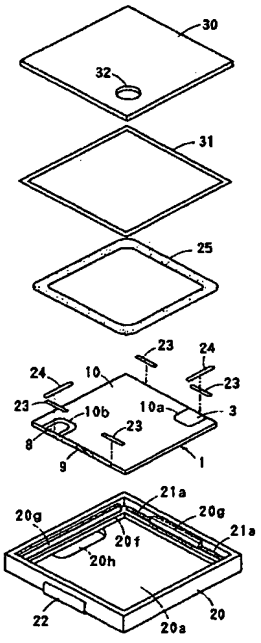
落下高さ	従来構造	本発明構造
１００ｃｍ	○	○
１２０ｃｍ	×	○
１５０ｃｍ	×	○
１８０ｃｍ	×	○

【００２９】
図７は本発明にかかる圧電振動板の他の実施例を示す。
この圧電振動板は、図４～図６に示した圧電振動板１をこれより大型の樹脂フィルム１５の上に接着したものである。樹脂フィルム１５としては、厚さ５～１０μｍ程度で、ヤング率が５００ＭＰａ～１５０００ＭＰａの材料がよく、具体的にはエポキシ系、アクリル系、ポリイミド系、ポリアミドイミド系などの樹脂フィルムが使用される。
このような大型の樹脂フィルム１５の中央部に圧電振動板１を貼り付け、樹脂フィルム１５の外周部を筐体の支持部に固定すれば、圧電振動板１を強く拘束することなく支持することができ、圧電振動板１が一層振動しやすくなる。そのため、圧電振動板１の変位量を大きくすることができ、高い音圧を得ることができるとともに、圧電振動板１の寸法を小さくしても同等の共振周波数を得ることができる。また、基本共振から３次共振まで落ち込みのない音圧が得られ、広帯域音声の再生に対応できる。
【００３０】
本発明は上記実施形態に限定されるものではなく、本発明の趣旨を逸脱しない範囲で変更可能である。
上記実施形態の圧電振動板は２層の圧電セラミックス層を積層したものであるが、３層以上の圧電セラミックス層を積層したものでもよい。
また、ケース２０の内周に圧電振動板１の４辺を支持する環状の支持部２０ｆを設けたが、圧電振動板１の２辺または４つのコーナ部を支持する支持部を設けてもよい。
本発明の筐体は、圧電振動板を収納し、外部端子あるいは電極を設けたものであればよく、実施形態のような凹断面形状のケースと、その上面に接着される蓋板とで構成されたものに限らない。
【００３１】
【発明の効果】
以上の説明で明らかなように、請求項１に記載の発明によれば、圧電振動板の表裏面に形成される樹脂層の第１，第２切欠部を互いに対向しない位置に形成したので、この圧電振動板を筐体に収納固定した状態で落下衝撃が加わった場合に、切欠部から露出した積層体の部分にクラックが発生するのを防止でき、落下衝撃に対する耐衝撃性を大幅に向上させることができた。また、表裏の樹脂層に切欠部がそれぞれ設けられているので、側面電極を主面電極の表側に回り込ませることができ、表裏の主面電極と側面電極との導通信頼性を確保することができる。
【図面の簡単な説明】
【図１】本発明に係る圧電型電気音響変換器の第１実施形態の分解斜視図である。
【図２】図１に示す圧電型電気音響変換器の蓋板および弾性封止剤を除外した状態の平面図である。
【図３】図２のＡ－Ａ線階段断面図である。
【図４】図１の圧電型電気音響変換器に用いられる圧電振動板の斜視図である。
【図５】図４のＢ－Ｂ線による階段断面図である。

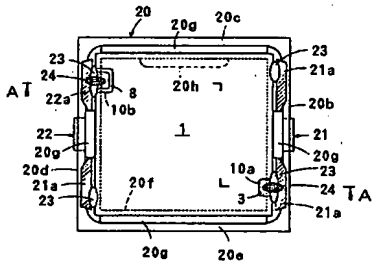
【図６】図４の圧電振動板の分解斜視図である。
【図７】本発明にかかる圧電振動板の他の例の斜視図である。
【図８】従来の圧電振動板の一例の斜視図である。
【図９】図８のＣ－Ｃ線断面図である。
【図１０】図８の圧電振動板の平面図である。
【符号の説明】

1	圧電振動板
2	積層体
3，4	主面電極
5	内部電極
7	第１側面電極
8	引出電極
9	第２側面電極
１０，１１	樹脂層
１０ａ	第１切欠部
１０ｂ	第３切欠部
１１ａ	第２切欠部
２０	ケース
２１，２２	端子
２４	導電性接着剤
２５	弾性封止剤
３０	蓋板

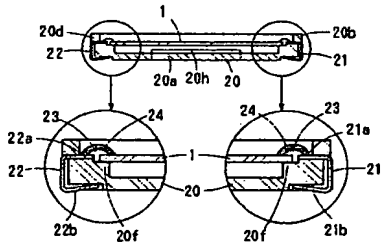
【図１】



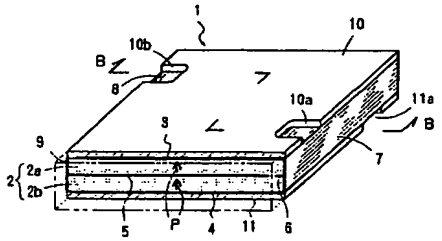
【図２】



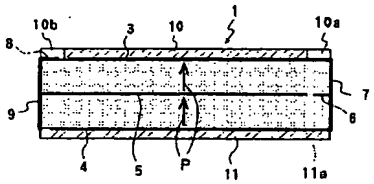
【図３】



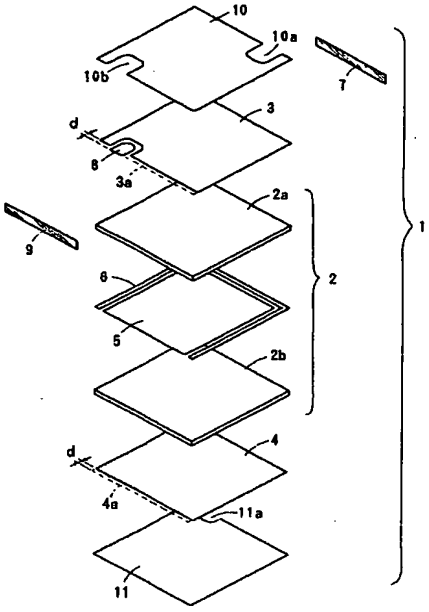
【図４】



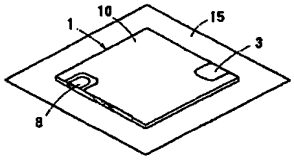
【図５】



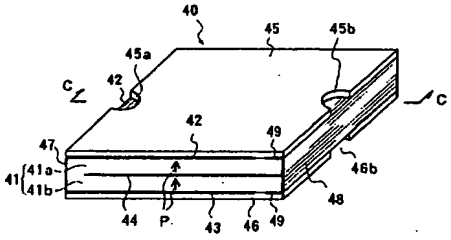
【図６】



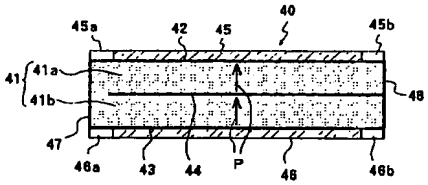
【図７】



【図８】



【図９】



【図１０】